TANGANYIKA TERRITORY—DEPARTMENT OF AGRICULTURE

SISAL EXPERIMENTAL STATION ANNUAL REPORT FOR THE YEAR 1946

PART I.—Staff

1. *European.*—Mr. G. W. Lock, O.B.E., Senior Agricultural Officer, was in charge of the station throughout the year, assisted by Mr. E. Pienaar, Agricultural Assistant. Mr. E. Pienaar returned from annual leave on 13th January and he also left for annual leave on 23rd December. Mr. G. W. Lock was absent on local leave from 13th June to 12th July. During the year he undertook part-time duties as Advisory Officer, Sisal Control. The visit to East Africa by Dr. P. I. Wilson, Research Chemist, who is employed by the London Sisal Growers' Association on sisal fibre research, and who normally works at Leeds University under Professor Speakman, was extended to two years to enable him to continue with his studies at the station.

2. *African.*—The African staff has remained almost unchanged and comprises one clerk, six computers, one senior recorder, twenty-two recorders and nine probationers, one senior and six recorders are employed on the external trials. One laboratory assistant and five probationers are working on fibre testing.

3. The attendance of regular labourers has been satisfactory, but the total number of labourers, although slightly increased, has been insufficient for the work of the station. The majority of the labourers are employees of long-standing who are accustomed to field experimental methods.

4. *Touring.*—Apart from numerous visits to local estates, the Senior Agricultural Officer made three extensive tours of the Central Line estates during the year. Two visits were made to Nairobi in connection with the East African Agricultural Research Conference and later to attend a joint meeting held by the East African Governors' Conference to consider an application for an increase in the price of sisal. In September the Senior Agricultural Officer and Dr. P. I. Wilson were invited to meet Professor Sir Ian Heilbron and Professor Simonsen in Moshi to discuss sisal utilization research, the application of modern insecticides against sisal weevil, and the use of herbicides. A meeting of the Tanganyika Sisal Board held in Dar es Salaam was attended in December. Six estates applying for additional land for sisal growing were visited and reports submitted to the Sisal Board.

Weather

5. The total rainfall for the year amounted to 47·68 inches spread over 120 days. Although this figure approximates the average annual rainfall for Mlingano, the distribution was by no means normal. The main rains were disappointing and they neither afforded sufficient relief to a previous drought lasting ten months nor provided a long enough planting period. Dry weather ensued until mid-September when there were unusually heavy rains; nearly 25 inches were recorded during September and October alone. Maximum temperatures up to 35·5° C (96° F) were recorded during the hot season and they tended to be high during the year. There was an increase in the number of hours of sunshine compared with 1945.

6. *Planting work.*—No new experiments were planted during 1946. Two and a half acres of bush were cleared, cultivated and planted with graded bulbils ; owing to poor rains, growth was slow. The Agave Collection was rehabilitated and suckers of certain species planted, together with suckers of the more promising selected hybrids. Plots of cover crops for demonstration and seed multiplication were also put down. Five acres of derelict rubber were cleared in preparation for transplanting agave hybrids though the latter work was not undertaken due to the small size of the plants.

7. In order to alleviate the general food shortage thirty-six acres were ploughed but could not be sown with an early-maturing variety of maize until the end of April; yields were poor due to the late sowing date and an unsatisfactory season. Another five acres were planted with beans which failed. Seven acres of elephant grass were planted near the cattle sheds.

8. During the small rains a further ten acres were put under maize and bean with better results. Twenty acres were planted with cassava for a food reserve, partly with mosaic-free cuttings supplied by Amani. The latter have grown well.

9. *Buildings and Machinery.*—Ten new quarters were erected for African employees in the labour camp, together with a new hospital and a small canteen and social hall. All the European quarters and offices were redecorated inside and outside. No new machinery was acquired during the year other than a mechanical sisal leaf cutter sent for trials. A new box-body car was purchased for travelling in connection with the external trials.

10. *Water Supply.*—Until May there was a complete dearth of water on the station, and the shortage was overcome by transporting water from a borehole on Ngomeni Estate. Grateful thanks are due to Messrs. Kumburu Plantations, Ltd. for their invaluable assistance in tiding over this difficult period. The height of the existing dam and spillway had been raised by two feet before the main rains, but in May the depth of water only rose to nine feet though this immediately alleviated water supply difficulties. In September, however, the dam rapidly filled to overflowing, impounding seventeen feet of water. There is now every prospect that the present reservoir will suffice even during exceptionally dry years.

11. *Experimental Areas.*—Six of the original thirteen trials laid down in 1936 are being perpetuated for a second cycle and the various plots are replanted as required. In addition to the three complex experiments in progress, there is one trial comparing progeny rows of selected F1 hybrids of *Agave amaniensis* raised by the Geneticist, Amani. Young double-row sisal in the Fertility Trial has grown well despite the drought and received its first cutting in June. The season made the maintenance of trial areas relatively easy.

12. *Agave hybrids.*—The 1942 Agave hybrids were cut for yield measurements and some gave high fibre yields per plant. Rigorous selection work has begun and only plants having smooth-edged leaves are being retained, and these are subject to further selection before cross-pollination is carried out. The exclusion of thousands of unsuitable plants will reduce the amount of recording work. It is necessary to defer selection work until the plants have been in the field for four years in order to detect resistance to disease and weevil attack. A number of the F2 hybrids were tested for fibre fineness.

13. *Blue Sisal Plot.*—This one-hectare plot of Blue sisal (*Agav e amaniensis*) which is kept for demonstration purposes, was cut for a second time but no records of yields were made.

14. *External Trials.*—Both the Rudewa and Kingolwira 9 x 9 Quasi Latin Spacing x Cutting trials have made reasonably satisfactory progress in spite of the season.

It is expected that they will be ready for a first cutting in 1947. Owing to severe weevil attack and unsatisfactory rains last year, the stand of plants on the Amboni External trial was so variable that it was decided to uproot all the sisal. The trial was replanted in March using graded plants. This, together with daily collection of adult weevils, has given better results although the uniformity of the sisal is not all that could be desired. Rainfall and growth records are maintained at each trial by resident African recorders.

15. *Pests and Diseases.*—The sisal weevil (*Scyphophorus acupunctatus*) did no cause noticeably worse damage this year though it was frequently severe in the Agave hybrids. Preliminary trials were made with Gammexane dusts against the sisal weevil. Laboratory tests, using various strengths and rates of application all proved lethal finally, though two grams per plant of the 1 per cent strength acted quickest. Field trials were not so successful and considerably more investigational work is still required before a practical method of control employing insecticides can be found. This work is being continued in collaboration with the Entomologist, Morogoro. Bole rot was less evident this year.

16. *Citrus.*—The drought of 1945 and 1946 and the consequent water shortage, gave a severe setback to the propagation of citrus. In April the main nurseries were transferred to a site near the labour camp where the beds can be watered. 1,835 budded citrus trees were sold to sisal estates and others. Sales of grapefruit continued. The citrus plantation, which occupies a sheltered valley bottom, withstood the dry weather remarkably well.

17. *Stock.*—On the whole the cattle maintained good health during the year although the number of cases of *trypanosomiasis* were higher than usual. Seven calves were born, but deaths included four calves, some from food poisoning, a cow which died after calving and three other young stock. By the end of the year twenty-four head of stock were housed in the fly-proof byres.

18. *Acknowledgments.*—The co-operation of Messrs. Kumburu Plantations, Ltd., who continued to afford the station every facility for decorticating experimental leaf at Ngomeni Estate, is gratefully acknowledged. Messrs. Bird and Co. (Africa) Ltd., also kindly rendered assistance both in their factory and workshops on Geiglitz Estate.

19. *Management Committee.*—Since the merging of the T.S.G.A. Research Committee and the Mlingano Management Committee, the members of the new Committee are as follows: R. W. R. Miller, Esq., C.M.G., Director of Agricultural Production, Chairman, E. Birrell, Esq., A. L. Du Bois, Esq., M. A. Carson, Esq., M.L.C., P. A. Feer, Esq., M. E. Hay, Esq., E. F. Hitchcock, Esq., C.B.E., G. W. Lock, Esq., O.B.E., and J. E. Wilkins, Esq. Progress reports are submitted to this body periodically.

20. *Visitors.*—Among the many visitors to the station during 1946 were the Rt. Hon. A. Creech-Jones, Secretary of State for the Colonies, His Excellency the Governor, Sir William Battershill, K.C.M.G., A. B. Cohen, Esq., Colonial Office, Sir Harold Tempany, Agricultural Adviser to the Secretary of State for the Colonies, Sir Frank Engledow, School of Agriculture, Cambridge, Professor J. W. Munro, Imperial College, London, Colonel C. E. Ponsonby, M.P., Sir John Reynolds, Bt., Sir Charles Lockhart, C.B.E., R. W. R. Miller, Esq., C.M.G., the Provincial Commissioner, Tanga, E. F. Hitchcock, Esq., C.B.E., and Major J. P. Hearle.

PART II.—Review of Experiments

The protraction of the dry weather prevailing during the latter half of 1945 into the first eight months of 1946 constituted a drought of a severity unprecedented in the history of the Station. As the drought intensified the growth rate of the sisal declined steadily irrespective of cultural conditions. This reached a climax during

the first quarter of 1946 when growth was practically at a standstill and on the average only one leaf was unfurled per plant each month. The sisal did not, however, reach the point of collapsing through water shortage. It was later revivified by the main rains though these were meagre and short-lived. Thereafter the monthly growth rate fluctuated between three and four leaves per plant but it tended to be lower than would normally be the case notwithstanding torrential rains in September.

Despite early planting, the 1946 bulbil nurseries were unusually backward; nevertheless it is hoped that the plants will eventually be large enough for transplanting next year. Apart from replanting one external trial at Amboni, no new trials were laid down during the year. In such a season sisal experiments could not be established successfully and a high degree of uniformity would have been difficult to attain.

Previous reports have included the complete end results for a number of the earlier trials conducted on the Station. These afforded many useful deductions for the guidance of the sisal grower as well as for the design of new experiments. No further final results can be given in the present report because all the current trials are still in the interim stage. The data quoted later shows only the progress of these experiments and consequently it is too soon to form definite conclusions from the results obtained up to the present time.

It is of interest, however, to trace the factors which have influenced the design of the second series of trials. One aspect is concerned with questions of soil moisture and soil fertility, both essential for satisfactory growth. The original Cultivation Trial No. 1 yielded results overwhelmingly in favour of continuous clean weeding. Any form of weed or cover crop competition exerted a depressing effect upon growth and fibre yields, varying according to the degree of control by weeding or cutlassing. After two years' study of the progress of this trial, it was conceived that weed competition was of greatest consequence when the sisal was young, and that it might prove unnecessary to carry on with the harmful process of clean weeding throughout the life-cycle. This conception was confirmed in Cultivation Trial No. 2 wherein all the sisal was kept clean weeded for two years and thereafter various degrees of soil cover were allowed to develop. The final results showed no significant differences in fibre yields. (Annual Report, 1944).

Concurrently with the above trials, the spacing experiments had indicated that population of plants per hectare was a more important factor affecting total fibre yields than the actual espacement used. In another trial sisal spaced in double-rows four metres apart was giving results differing very little from that planted in single rows.

It was then envisaged that the extra space afforded by the double-row method could be utilized for growing a partial soil cover, thus representing a further departure from entire clean weeding. Cultivation treatments varying from clean tillage by tractor and disc-harrow, inter-row cultivation of a leguminous cover crop (*Glycine javanica*), and interplanting of elephant grass (*Pennisetum purpureum*) were then embodied in the Fertility trial planted in 1944.

Although this latest trial is not yet finished, the results obtained so far apply to the most crucial years in the life of sisal. They show that it is possible to grow a recumbent cover crop in the four metre strip separating the twin rows of young sisal without checking the growth of the sisal, or causing a significant decrease in fibre yields such as was experienced when a cover crop was grown in sisal planted in single rows.

It is safe to state at this stage of the trial that the manifold advantages of the 4×1 metre spacing system far outweigh its inherent disadvantages. The adoption of this system on estates can now be confidently recommended. The system fulfils the majority of the needs of the sisal grower through providing access at all times for cultural operations some of which can be mechanised. A paramount consideration is that the soil may be protected both from exposure and erosion.

Cultivation Trial

Layout: 6×6 Latin Square.
Plot size: 25 recorded plants spaced 3m.×1m.
Planted: April 1936.
Treatments: A. Uncontrolled weed and bush growth.
B. Weeding twice annually.
C. Surface clean weeding.
D. Cover crop (*Calapogonium mucunoides*).
E. Clean weeding and deep cultivation.
F. Weeds cutlassed twice annually.

This trial is being perpetuated on the lines of a "classical experiment" in order to determine the effect of continuous sisal growing on the same land upon the rate of soil exhaustion under different degrees of weed cover. Full details of the first cycle results were published in the 1945 annual report. Plots were replanted as soon as was practical after the original plants had poled. Since the duration of the first cycle varied widely between the six treatments, replanting occurred in different years so that at the present time the second cycle sisal is in all stages of development. The clean weeded treatments are approaching the poling phase in the second cycle, whereas the neglected sisal has just finished and the plots will become due for replanting next year.

TABLE I.—Cultivation Trial No. 1

Summary of Yields up to 31st December 1946

	Clean Weeding: Shallow C	Clean Weeding: Deep E	Weeding Twice Annually B	Cover Crop D	Weeds Cutlassed F	Uncontrolled weeds A	Significant Diff.
FIBRE YIELDS							
Tons per Hectare—							
1st cycle	14·44	14·46	12·10	11·81	11·67	11·34	1·04
2nd cycle	9·77	9·93	2·33	3·15	—	—	—
Total to date (10 years, 8 months)	24·21	24·39	14·43	14·96	11·67	11·34	1·67

Table I shows the aggregate fibre yields obtained under each treatment during the past ten years. The quick-growing-clean weeded sisal has obviously outstripped that subjected to weed competition which has grown more slowly and less vigorously during its young periods. The figures are impressive and demonstrate that clean weeding gives a rapid turnover although this is achieved regardless of the maintenance of fertility. The principal benefit of weeding appears to be that of conservation of soil moisture. This is conducive to rapid initial growth which enables more leaves to be cut per plant and reduces the loss of the earliest leaves through withering.

TABLE II.—Cultivation Trial

Comparison of First and Second Cycle Yield Data

	Clean weeding surface C		Clean weeding deep E		Weeding twice annually B		Cover crop D	
CYCLE	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Fibre Yields—								
Tons per Hectare	13·05	8·33	12·19	8·62	6·92	2·33	8·12	3·15
Percentage fibre extraction	3·55	3·34	3·54	3·39	3·26	2·99	3·28	2·76
Mean No. of leaves—								
(i) Grown per plant up to time of last cut	217	188	212	190	181	132	194	146
(ii) Cut per plant	168	119	162	129	98	51	108	69
(iii) Lost per plant	36	46	31	45	58	53	61	54
Mean Weight of a single leaf (gms.)	655	631	636	590	651	455	687	497
Periods in months	59	58	59	58	49	59	49	59

A final comparison between the fibre yields of the first and second cycles of the clean-weeded treatments is not possible at this stage, nor can the full effects of soil deterioration be ascertained. The figures in Table II give the results obtained during periods of approximately the same duration in both the first and second cycles respectively, beginning from the time of planting. It will be observed that the second cycle fibre yields lag behind those of the first cycle by 4·7 tons per hectare in the case of surface clean-weeding and 3·6 tons per hectare for the deep cultivation treatment. Only tentative conclusions can be formed at present in regard to the influences of seasonal effects (causing slower growth) and declining soil fertility upon yields.

These differences are to a certain extent attributable to less favourable climatic conditions prevailing during the second cycle period. The total rainfall for the first cycle period (59 months) amounted to 250·52 inches compared with 213·28 inches for the second cycle period (58 months), or a difference of 37·24 inches. The second planting grew more slowly when it was young giving rise to a higher loss of the earliest leaves through withering before the first cutting. This might account for a reduction in fibre yields of the order of 0·4 tons per hectare.

The total number of leaves grown during the second cycle up to June 1946 was about twenty-five fewer per plant, possibly representing about 2·0 tons of fibre per hectare. A significant feature is that whereas treatments C and E have only yielded 64 and 71 per cent respectively of the first cycle fibre yield during a similar period in the second cycle, the number of leaves grown represents 87 and 90 per cent respectively. After allowing for the retarded growth and the extra loss of young leaves, together estimated at 2·4 tons per hectare, the adjusted second cycle yields would become 10·7 and 11·0 tons for the two treatments compared with 13·0 and 12·2 tons for the first cycle period. It is suggested that this shortfall is largely due to soil deterioration and it is already evident that the final yields of the second cycle will not be so good as those of the first cycle. Another indication may be found in the lighter leaf obtained.

The data for the periodically weeded and cover crop plots does not afford any close comparisons as yet. Yields to date are lower but the sisal has grown less quickly. Less rain during the second cycle period would tend to intensify the competition for soil moisture by a cover crop or weeds and retard the growth of the sisal. It is still far too early to detect if a living soil cover, whether grown periodically or continuously, has had any effect upon the maintenance of soil fertility.

Spacing Trial (*A. sisalana*)

Layout: 6 randomized blocks of eight plots each.
Plot size: 120 square metres.
Planted: May 1936.

Treatments:	Distance (metres)	Density (plants per hectare)
A	2 × 0·50	10,000
B	3 × 0·50	6,666
C	2·40 × 0·65	6,410
D	2 × 1	5,000
E	2·40 × 1	4,166
F	3 × 1	3,333
G	2 × 2	2,500
H	3 × 2	1,666

TABLE III.—Sisalana Spacing Trial

Combined Fibre Yields for First and Second Cycles

Fibre Yields tons per Hectare—	10,000 A	6,666 B	6,410 C	5,000 D	4,166 E	3,333 F	2,500 G	1,666 H	Sig. Diff.
1st cycle	32·37	23·22	21·18	16·72	14·13	11·95	7·62	5·34	1·31
2nd cycle	—	—	1·07	1·35	8·47	9·12	10·38	6·67	—
Total do date (10 yrs. 9 mths.)	32·37	23·22	22·25	18·07	22·60	21·07	18·00	12·01	1·62

The current results of this trial are set out in Table III. Treatment A (10,000 plants per hectare) has been in continuous cropping since the first cutting taken in 1939 and although poling has been heavy there are still a few surviving plants. In all the other treatments a hiatus in cropping occurred due to replanting between the first and second cycles. Treatments G and H are close upon the end of their second cycle, 97 per cent of the plants having poled.

When the results are regarded from the angle of yield in a given time, it is obvious that treatment A should exceed all the others. The cumulative yields from densities ranging from 3,333 to 6,666 plants per hectare do not vary a great deal at this juncture but as the sisal at the higher densities becomes more advanced differences in total yields will inevitably be more pronounced. A trend similar to that of the first cycle may be expected.

Treatments G and H show better results in the second cycle than during the first cycle the chief reason being that cutting began earlier in the second cycle and not so many of the early leaves were lost.

TABLE IV.—Spacing Trial (*A. sisalana*)

Summary of Fibre and Leaf Data from 1st and 2nd Cycles

Treatments: F and E.

Period	F 3,333/Ha. 1st cycle (49 months)	F 3,333/Ha. 2nd cycle (53 months)	E 4,166/Ha. 1st cycle (49 months)	E 4,166/Ha. 2nd cycle (53 months)
FIBRE DATA				
Fibre Yields tons per Hectare—				
1st Cut	3·45	2·23	3·57	2·19
2nd Cut	3·34	2·89	3·30	2·77
3rd Cut	3·39	4·00	3·60	3·50
Total ...	10·18	9·12	10·47	8·46
Percentage fibre extraction				
1st Cut	2·85	2·73	2·93	2·66
2nd Cut	3·39	3·37	3·33	3·23
3rd Cut	4·57	4·30	4·33	3·95
LEAF DATA				
Mean No. of leaves cut per plant—				
1st Cut	57·2	46·4	52·0	40·4
2nd Cut	35·3	35·3	31·2	31·3
3rd Cut	38·3	39·5	34·9	31·4
	130·8	121·2	118·1	103·1
No. of leaves lost per plant ...	67·0	40·2	64·5	39·7
Mean No. of leaves grown at time of third cut	218	178	203	167

Table IV is a comparative statement of the first three cuttings of treatments E and F during the first and second cycles respectively. In the second cycle, the yields of the first and second cuttings are lower. This is due to earlier commencement of cutting which has resulted in the loss of only 40 leaves per plant against about 65 leaves per plant during the first cycle and, of course, a lighter crop at the initial cutting. Furthermore the second cycle sisal has grown about 170 leaves per plant and consequently it is not as forward as the first cycle sisal at the time of its third cutting. Despite the fact that treatments E and F are some 40 leaves per plant behind their counterparts in the first cycle, leading to lower yields and slightly reduced fibre percentages, the figures for the third cutting compare quite favourably. It can be stated that this is a cutting effect rather than one due to spacing.

The aggregate yields for the first and second cycles are in favour of the first cycle at this stage. If, however, allowance is made for the difference of 40 leaves per plant in leaf production, estimated over 2 tons of fibre per hectare, the second cycle yields could appear to approximate those of the first cycle. It is thus still too early to detect the effect of plant density upon the rate of soil deterioration under these particular treatments.

Spacing × Cutting Trial

Layout: 9 × 9 Quasi—Latin Square.
Plot size: Varies from 50-69 square metres according to the spacing treatment.
Planted: April 1942.

Spacing Treatments:

Population:

a_0	=	4,000 plants per hectare.
a_1	=	5,000 ,, ,, ,,
a_2	=	6,000 ,, ,, ,,

Spacing Between Rows:

b_0	=	2·5m. between rows.
b_1	=	2·0m. ,,
b_2	=	4m. × 1m. ,,

Combinations of the a and b treatments give the following spacings:—

$a_0 b_0$	=	2·5m. × 1m.
$a_0 b_1$	=	2·0m. × 1·25m.
$a_0 b_2$	=	4·0m. × 1m. × 1m.
$a_1 b_0$	=	2·5m. × 0·80m.
$a_1 b_1$	=	2·0m. × 1·0m.
$a_1 b_2$	=	4·0m. × 1·0m. × 0·80m.
$a_2 b_0$	=	2·5m. × 0·67m.
$a_2 b_1$	=	2·0m. × 0·83m.
$a_2 b_2$	=	4·0m. × 1·0m. × 0·67m.

Cutting Treatments:

Commencement of cutting:

c_0	=	Commence cutting at two years.
c_1	=	Commence cutting at two and a half years.
c_2	=	Commence cutting at three years.

Cutting Cycles:

d_0	=	9 months cycle.
d_1	=	12 months cycle.
d_2	=	15 months cycle.

The design of this trial comprises nine cutting systems superimposed on nine different spacings, and the layout is such that comparisons are afforded between the main treatment effects and two factor interactions. The trial has now been in progress for four years and eight months; all the plots have been cut according to programme and it is anticipated that some may begin to pole next year. The figures given below are not final and no definite conclusions can be formed at this stage.

TABLE V.—Spacing and Cutting Trial—Spacing Effects

Summary of Fibre and Leaf Data Results to 31st December 1946

Treatments grouped for population densities:—

	4,000	5,000	6,000
FIBRE DATA			
Yield in tons per Hectare	9·04	9·33	8·92
Percentage Fibre Extraction	3·39	3·24	3·24
Mean Weight of fibre per leaf (gms.)	23·6	21·7	20·1
LEAF DATA			
Mean No. leaves cut per plant	102·4	92·1	80·9
Mean Weight of a single leaf	661	657	597
Mean No. leaves grown since planting	195·0	186·1	172·2

Differences in fibre yields for the three plant populations are not very marked since poling effects have not yet become operative. Likewise the mean extracted fibre percentages over all cuttings to date show little variation. The actual average content of fibre in the leaf tends to become slightly less as the population increases, though it would be premature to attach any significance to the figures because of a disparity in the growth rates.

The leaf data reflects the effects of plant population upon the rapidity of growth. As the former increases, the number of leaves unfurled since planting decreases. This in turn has obviously affected the mean number of leaves cut per plant to date. Reductions in the latter have been compensated by higher plant populations resulting in narrow differences between current fibre yields. The slightly lighter leaf from the 6,000 population is partly attributable to the fact that fewer of the later and heavier leaves are included in the crop obtained up to the present time.

TABLE VI.—Spacing × Cutting Trial—Spacing Effects

Treatments grouped for Spacing between rows :—

	2·5	2·0	4 × 1
FIBRE DATA			
Yield in tons per Hectare ...	9·54	9·61	8·08
Percentage Fibre Extraction	3·26	3·33	3·29
Mean Weight of fibre per leaf (gms.)	21·7	21·5	22·1
LEAF DATA			
Mean No. of leaves cut per plant...	96·7	95·6	83·0
Mean Weight of a single leaf	650	637	628
Mean No. leaves grown since planting	186·8	189·7	176·9

Single-row spacing continues to show a superiority in growth over double-row spacing which has led to higher yields to date. Last year the difference in fibre yields was about one ton in favour of single row, and this has now risen to nearly one and a half tons. This suggests that plant-to-plant competition is still more intensified in the double-row, possibly accentuated by the low rainfall of past years. It should not be assumed from this data that single-row is better than double-row spacing in all respects. The point to note is that double-row sisal tends to grow a little more slowly than single-row sisal.

TABLE VII.—Spacing × Cutting Trial—Cutting Effects

Treatments grouped for commencement of cutting

FIBRE DATA:	c_0 2 years	c_1 2½ years	c_2 3 years
Yield in tons per Hectare ...	10·45	9·25	7·53
Percentage Fibre Extraction	3·29	3·36	3·20
Mean Weight of fibre per leaf (gms.)	19·8	22·0	24·4
LEAF DATA:			
Mean No. of leaves cut per plant ...	115·4	92·8	67·1
Mean Weight of a single leaf	572	641	730
Mean No. of leaves grown since planting...	187·6	182·5	183·2

Treatments Grouped for Cutting Cycles

FIBRE DATA:	d_0 9 months	d_1 12 months	d_2 15 months
Yield in tons per Hectare ...	10·56	8·37	8·36
Percentage Fibre Extraction	3·39	3·29	3·30
Mean Weight of fibre per leaf (gms.)	22·3	21·1	21·8
LEAF DATA:			
Mean No. of leaves cut per plant	104·0	87·5	83·8
Mean Weight of a single leaf	649	622	673
Mean No. of leaves grown since planting	185·5	184·5	183·3
Leaf length at 7.2.47	114·1	115·0	117·1

Number of cuts taken up to January 1947

c_0d_0	=	4	c_1d_0	=	4	c_2d_0	=	3	d_0	=	11
c_0d_1	=	3	c_1d_1	=	3	c_2d_1	=	2	d_1	=	8
c_0d_2	=	3	c_1d_2	=	2	c_2d_2	=	2	d_2	=	7
c_0	=	10	c_1	=	9	c_2	=	7		=	26

Since the figures in Table VII are of an interim nature it is not possible to make any comparisons. It may be noted, however, that postponement of the first cutting until three years has almost doubled the loss of early leaves and this may well have an important bearing upon ultimate fibre yields. Certain of the single row plots, cut late and infrequently, gave exceptionally heavy yields at each cutting, whereas the yields of those having double-row spacing were more modest.

Interactions.—A closer examination of the results obtained to date is afforded by the following two-way tables (Tables VIII and IX). The most interesting comparisons at this stage may be seen in the interactions between plant populations and distance between rows (a × b), and plant population and commencement of cutting (a × c).

TABLE VIII.—Spacing × Cutting Trial—1942

Two-way Tables $a \times b$ *Treatments*

FIBRE YIELDS (t.p. Ha.)		Plant Population: No. of plants per Ha.			Distance between rows
Distance between rows:—		a_0 4,000	a_1 5,000	a_2 6,000	b —
2·5m.	b_0	9·80	9·77	9·06	9·54
2.0m.	b_1	9·00	9·98	10·03	9·61
4 × 1m.	b_2	8·32	8·24	7·67	8·08
Plant Population	a	9·04	9·33	8·92	—

FIBRE PERCENTAGE		a_0	a_1	a_2	b
	b_0	3·36	3·18	3·24	3·26
	b_1	3·43	3·32	3·26	3·33
	b_2	3·39	3·24	3·25	3·29
	a	3·39	3·24	3·24	—

MEAN WEIGHT OF FIBRE PER LEAF (Gms.)		a_0	a_1	a_2	b
	b_0	23·3	21·6	20·3	21.7
	b_1	23·0	21·7	20·2	21·5
	b_2	24·9	21·9	19·7	22·1
	a	23·6	21·7	20·1	—

MEAN NO. OF LEAVES CUT PER PLANT		a_0	a_1	a_2	b
	b_0	111·2	97·0	81·9	96·7
	b_1	101·6	96·7	88·7	95·6
	b_2	94·4	82·5	72·1	83·0
	a	102·4	92·1	80·9	—

MEAN WEIGHT OF A SINGLE LEAF (Gms.)

	a_0	a_1	a_2	b
b_0	681	666	603	650
b_1	652	658	602	637
b_2	651	647	585	628
a	661	657	597	—

NO. OF LEAVES GROWN PER PLANT AT 7.2.47

	a_0	a_1	a_2	b
b_0	197·3	188·6	174·4	186·8
b_1	198·1	192·1	178·9	189·7
b_2	189·7	177·1	163·3	176·9
a	195·0	186·1	172·2	—

LEAF LENGTH AT 7.2.47 IN Cms.

	a_0	a_1	a_2	b
b_0	112·5	114·6	118·3	115·1
b_1	105·5	112·8	118·1	112·1
b_2	113·1	112·1	121·6	118·9
a	110·4	116·5	119·3	—

Fibre Yields.—The salient feature of these figures is that all the double-row spacings have yielded less fibre up to the present than the single-row spacings, irrespective of plant population. Double-row at 6,000 plants per hectare has given the lowest yield so far. The full effects of the three plant populations will not be observable until all the sisal has poled.

Fibre Percentages.—Despite rather variable fibre yields, differences in the mean percentages of extracted fibre for all the treatments are comparatively small and are probably insignificant. A contributing factor may be that the slower-growing high density or double-row sisal actually received its first cut at an earlier point in its life-cycle (when measured in number of leaves grown) than the faster-growing sisal, although cutting began at the same time in all cases.

Mean weight of fibre per leaf.—As regards the average content of fibre in a single leaf, it will be observed that this tends to vary inversely with plant population and is hardly affected by the distance between the rows of sisal.

Mean number of leaves cut per plant.—To-date most leaves have been cut from the single row spacings which give a plant population of 4,000 per hectare. As the plant density rises, so the number of leaves cut per plant decreases independently of the distances between the rows. Once again the figures for the double-row reflect slower growth and fewest leaves have been cut per plant from the plots having a density of 6,000 plants planted in double-rows. Such reductions have to a considerable extent been made good by higher plant populations; thus the fibre yields per hectare do not vary so widely as the mean number of leaves cut from each plant.

Mean weight of a single leaf.—These figures suggest that plant-to-plant competition has more effect upon the size of the leaf than espacement. Not so many of the later and heavier leaves have been cut at the higher densities and this is a partial explanation of the lighter leaf obtained up to the present time.

Number of leaves grown per plant.—The growth records portray the influence of both plant population and distance between rows upon the rate of unfurling new leaves. Once more plant density is shown to have a more important bearing upon growth than the spacing between the rows. Growth is retarded as the plant population rises; to a significant but lesser degree it has also been checked by planting in double-rows. The backward treatments may be expected to be amongst the last to pole out and ultimately this might radically alter the total fibre yields obtained.

TABLE IX.—Spacing × Cutting Trial—1942

Two-way Tables *a × c Treatments*

FIBRE YIELDS (tons per Ha.)

		Plant Population No. of plants per Ha.			Commencement of Cutting
		a_0 4,000	a_1 5,000	a_2 6,000	c —
2 years	c_0	10·6	10·3	10·6	10·5
2½ years	c_1	9·1	9·7	8·9	9·2
3 years	c_2	7·4	7·9	7·3	7·5
Plant Population	a	9·0	9·3	8·9	—

FIBRE PERCENTAGE

	a_0	a_1	a_2	c
c_0	3·36	3·24	3·26	3·29
c_1	3·50	3·32	3·29	3·36
c_2	3·29	3·15	3·17	3·20
a	3·39	3·24	3·24	—

MEAN WEIGHT OF FIBRE PER LEAF (Gms.)

	a_0	a_1	a_2	c
c_0	21·3	19·4	18·6	19·8
c_1	23·5	22·6	20·0	22·0
c_2	27·0	24·0	22·2	24·4
a	23·6	21·7	20·0	—

MEAN WEIGHT OF A SINGLE LEAF (gms).

	a_0	a_1	a_2	c
c_0	603	578	535	572
c_1	661	667	594	641
c_2	745	756	688	730
a	661	657	597	—

NO. OF LEAVES GROWN AT 7.2.47

	a_0	a_1	a_2	c
c_0	198·8	189·2	174·9	187·6
c_1	193·3	184·1	170·0	182·5
c_2	192·9	185·1	171·7	183·2
a	195·0	186·1	172·2	—

LEAF LENGTH AT 7.2.47 IN Cms.

	a_0	a_1	a_2	c
c_0	107·4	117·7	116·7	113·9
c_1	112·7	116·2	120·4	116·4
c_2	111·1	115·6	120·9	115·9
a	110·4	116·5	119·3	—

NO. OF LEAVES CUT PER HECTARE

	a_0	a_1	a_2	c
c_0	517,200	573,500	612,600	567,800
c_1	407,600	466,500	498,200	457,400
c_2	303,600	341,000	342,500	329,000
a	409,600	460,500	484,400	—

With reference to the data given in Table IX, it is important to reiterate that not all the treatments have received the same number of cuttings up to the time of this report. It is therefore not possible to make any useful comments and the figures merely indicate the results obtained to date for three plant populations, each having been cut for the first time at three different periods from planting.

The mean weight of fibre per leaf for the sisal cut at two years is less than for the sisal left until three years largely because it includes the earliest leaves. In the latter case, these withered and were lost.

It is noteworthy from the data on leaf length that early commencement of cutting has not dwarfed the sisal.

The total number of leaves cut per hectare obviously varies according to the number of cuttings taken, but it also tends to rise with increased population at each level of commencement of cutting. This numerical superiority has so far been offset by lighter leaf and slightly lower fibre contents because the fibre yields for each of the c treatments do not vary appreciably up to the present.

FACTORIAL MANURIAL TRIAL

Layout : 3 × 3 × 3 × 3 design with nine blocks of nine plots each confounding 3 factor interactions.

Plot size : 24 recorded plants spaced 2·5m. × 1m. (4,000 plants per hectare).

Planted : April 1942.

Treatments : Applications in cwt. per hectare.

NITROGEN (Sulphate of Ammonia)	PHOSPHATE (Rock Phosphate)	POTASH (Sulphate of Potash)
n_0 = nil	p_0 = nil	k_0 = nil
n_1 = 3 cwt.	p_1 = 4½ cwt.	k_1 = 3 cwt.
n_2 = 6 cwt.	p_2 = 9 cwt.	k_2 = 6 cwt.

Number of applications:

t_0 = once (1942) t_1 = twice (1942, 1943) t_2 = thrice (1942, 1943, 1944).

This trial was sited on land which had previously carried one cycle of sisal and the population of plants was increased to 4,000 per hectare.

TABLE X.—Yield Data up to October 1946—3 Cuttings:

	Fibre Yields in tons per hectare	Leaf Data No. of leaves grown per plant	Leaf Data No. of leaves cut per plant
NITROGEN			
n_0 nil	9·06	168	112
n_1 3 cwt. per Ha. Sulphate of Ammonia	9·82	171	120
n_2 6 cwt. per Ha. Sulphate of Ammonia	10·00	171	120
Significant Difference	0·53	—	4
PHOSPHATE			
p_0 nil	9·41	169	117
p_1 4½ cwt. per Ha. Rock Phosphate	9·64	169	116
p_2 9 cwt. per Ha. Rock Phosphate	9·83	171	118
POTASH			
k_0 Nil	9·78	171	118
k_1 3 cwt. per Ha. Sulphate of Potash	9·61	170	118
k_2 6 cwt. per Ha. Sulphate of Potash	9·49	169	116
APPLICATIONS			
t_0 once	9·35	169	115
t_1 twice	9·28	169	115
t_2 thrice	10·25	172	120

The results of this experiment are not yet final and they may be modified later by the rate of poling. They have only been analyzed to the first order interactions. At the moment despite considerable differences in the amounts of fertilizers applied, differences in fibre yields have been small and certainly not of a magnitude to justify the cost of the manures.

As reported last year there is a significant response to nitrogen. The responses to phosphate and potash are not significant. Upon analysis it would appear that the former is mainly due to a significantly larger number of leaves having been cut per plant. This has resulted more from the preservation of the earliest leaves than from the number of leaves produced per plant up to date. Three applications of any fertilizer was significantly better than only one dressing in regard to fibre yields only. None of the first order interactions is significant.

NITROGEN MANURIAL TRIAL

Layout : 6 × 6 Latin Square.
Plot size : 25 recorded plants spaced 3m. × 1m.
Planted : April 1941.
Treatments : Nil Control.

N	15 cwt. Sulphate of Ammonia per hectare.
NP	15 cwt. Sulphate of Ammonia per hectare. 12 cwt. Rock Phosphate per hectare.
NK	15 cwt. Sulphate of Ammonia per hectare. 15 cwt. Sulphate of Potash per hectare.
NPK	15 cwt. Sulphate of Ammonia per hectare. 12 cwt. Rock Phosphate per hectare. 15 cwt. Sulphate of Potash per hectare.
NL	Residual of 50 cwt. ground agricultural lime per hectare applied in 1936 and 1937.

The nitrogenous and potassic dressings were applied in three equal portions in 1941, 1942 and 1943. The phosphatic dressings were applied in two equal portions in 1941 and 1942.

NITROGEN MANURIAL TRIAL

TABLE XI.—Fibre Yields in tons per Hectare

First and second cycles

	Treatments							Gen.	Si
	Nil	N	NP	NK	NPL	NL		Mean	Diff.
First cycle	14·8	15·6	14·7	15·5	14·5	15·4	...	15·0	0·77
Second cycle	12·6	12·9	12·1	12·5	11·6	12·9	...	12·4	Non-Sig
Mean No. of leaves grown per plant:									
First cycle	217	220	214	219	212	220	...	217	4·2
Second cycle	204	208	200	203	196	206	...	203	4·8
Mean No. of Leaves cut per plant:									
First cycle	190	193	181	192	180	193	...	188	—
Second cycle	165	168	159	164	152	169	...	163	—

The above data is complete since 94 per cent of the second cycle plants had poled and the remainder were cut out.

The differences in the treatment fibre yields for the second cycle are not significant. When the general means for the first and second cycles respectively are compared it will be seen that the latter has declined by 2·6 tons per hectare, despite artificia, manuring. A noteworthy feature that the second cycle sisal produced about fourteen leaves fewer per plant, and the reduction in number of leaves cut per plant was even greater. These poorer results can be attributed to less favourable climatic conditions as well as to a greater variation in plant size consequent upon weevil damage during the early years, but in the main they reflect a serious decline in soil fertility which has not been arrested by artificial manuring. It may have been possible, of course, that the applications of fertilizers, especially of nitrogen, were not heavy enough for a crop like sisal which yields huge tonnages of vegetable material.

PHOSPHATE MANURIAL TRIAL

Layout: 6 × 6 Latin Square
Plot size: 25 recorded plants spaced 3m. × 1m.
Planted: April 1941.
Treatments: Nil Control.

P	12 cwt. Rock Phosphate per hectare.
NP	15 cwt. Sulphate of Ammonia per hectare. 12 cwt. Rock Phosphate per hectare.
PK	12 cwt. Rock Phosphate per hectare. 15 cwt. Sulphate of Potash per hectare.
NPK	15 cwt. Sulphate of Ammonia per hectare. 12 cwt. Rock Phosphate per hectare. 15 cwt. Sulphate of Potash per hectare.
PL	12 cwt. Rock Phosphate per hectare. Residual of 50 cwt. ground agricultural lime per hectare applied in 1936 and 1937.

TABLE XII.—Fibre Yields in Tons per Hectare.

First and Second Cycles

	Treatments							Gen. Mean	Sig. Diff.
	Nil	P	NP	PK	NPK	PL			
First cycle	15·3	15·0	15·1	14·5	14·6	15·0		14·9	Non-sig
Second cycle	10·9	11·4	11·0	10·9	10·7	12·2		11·2	„
Mean number of leaves grown per plant:									
First cycle	223	218	218	216	214	218		218	3·1
Second cycle	196	198	196	194	194	202		197	Non-sig.
Mean number of leaves cut per plant:									
First cycle	194	187	186	187	183	189		188	4·9
Second cycle	150	149	149	145	146	154		149	Non-sig.

Both the Nitrogen and Phosphate Manurial trials ended their second cycle at the same time. The difference between the mean total fibre yields of the first and second cycles of the Phosphate Trial, amounting to 3·7 tons per hectare, is even greater than that recorded for the Nitrogen Trial. Here again none of the treatment differences is significant.

FERTILITY TRIAL

Layout: 6 randomized blocks of 6 plots each.
Plot size: 24 plants spaced 4m. × 1m. × 1m. (4,000 p. Ha.)

Treatments	First Cycle	Fallow Period
A	Disc-harrow clean weeding	... second cycle of sisal.
B	„ „ „ „	... 2 years bush fallow.
C	„ „ „ „	... 2 years leguminous fallow.
D	„ „ „ „	... 2 years elephant grass fallow.
E	Cover crop (*Glycine javanica*)	... sisal and cover crop.
F	Elephant grass intercropped for first two years	... Sisal intercropped with elephant grass for the first two years

In this long-range experiment the sisal has made good growth in two blocks, fairly satisfactory growth in two others and poorer growth in the remaining two blocks. Thus the good blocks were ready for a light initial cutting whereas the backward blocks were rather small when a first cutting was taken in June. Twenty-five leaves were left uncut per plant. It needs to be remembered that this sisal had to withstand a drought lasting nearly a year, or half its duration in the field.

TABLE XIII.—FERTILITY TRIAL—First Cutting June 1946

	Fibre Yields tons per hectare	No. of leaves per plant: Grown up to 26/6/46	No. cut	No. lost by withering
A.—Disc-harrow clean weeding	0·93	91·4	35·6	31·4
B.— „ „ „ „	0·80	89·6	35·0	29·6
C.— „ „ „ „	0·95	91·4	35·8	31·4
D.— „ „ „ „	0·89	92·0	35·7	32·0
E.—Cover crop (*Glycine javanica*)	0·87	88·2	35·8	28·2
F.—Elephant grass intercropped	0·22	67·6	21·3	7·6
Significant Difference (P = ·05)	·25	4·7	3·9	—

The first four treatments are the same at this stage of the trial. The main points to note about the yield figures are that (i) a low cover of *Glycine javanica* has neither reduced the fibre yield nor the number of leaves produced per plant significantly; and (ii) both fibre yield and growth have been severely depressed by intercropping with elephant grass (*Pennisetum purpureum*). The extremely low yield of the elephant grass plots is to some extent accounted for by a large number of the shortest leaves being lost during decortication.

Although this early cutting has given a small yield of fibre it is not necessarily uneconomic. It should not be regarded as purely a cutting operation because there are also benefits of a cultural nature. Removal of the lowest ("sand") leaves enables the double-row to be cleaned and the suckers removed before they are too large or numerous; grading for length is also simplified in subsequent cuttings. Results of other trials (1945 Report) indicated that early cutting, besides avoiding undue loss of lower leaves is conducive to a prolongation of the life of the sisal, partly through inducing the plants to produce a few more leaves before poling. In addition the fibre percentage is improved in later cuts. It is important, of course, that an early cutting should not be too severe otherwise the plants may become stunted.

The sisal in the elephant grass plots showed symptoms of drought at the beginning of the hot season. It was also short and yellow. Repeated disc-harrowing is tending to break down soil structure though a certain amount of weed growth has been ploughed into the soil.

The leguminous cover crop (*Glycine javanica*) withstood the long drought very satisfactorily. The amount of foliage was naturally reduced towards the end of the dry season, but an excellent neat cover some six inches high, developed soon after the beginning of the rains. No weeding has been necessary apart from cleaning the double rows after cutting. This system of sisal cultivation appears most promising at the moment and offers a means of combining proper management of the soil with good management of the sisal.

EXTERNAL TRIALS

Table XIV gives a summary of the growth records of the Spacing × Cutting trials now in progress at Rudewa and Kingolwira Estates on the Central Line.

TABLE XIV.—Analysis of Growth Records

Mean number of leaves grown per plant from planting in April 1945 to September 1946:

Treatments grouped for: Plant Population	Rudewa	Kingolwira
4,000 plants per hectare	61·5 ...	58·0
5,000 „ „ „	58·6 ...	56·9
6,000 „ „ „	58·9 ...	54·7
Distance between rows:		
2·50 metres...	60·6 ...	57·7
2·00 metres...	60·5 ...	57·0
4m. × 1m.	57·8 ...	54·8

Mean length of last unfurled leaf on 15.9.46 in centimetres.

Treatments grouped for: Plant Population	Rudewa	Kingolwira
4,000 plants per hectare	83·7 ...	74·4
5,000 „ „ „	82·9 ...	74·0
6,000 „ „ „	83·8 ...	72·3
Distance between rows:		
2·50 metres...	84·2 ...	74·8
2·00 metres...	83·6 ...	73·6
4m. × 1 m.	82·7 ...	72·3

The above data was extracted at a juncture when the sisal in both places had grown approximately the same number of leaves per plant. Subsequent to this point the Rudewa sisal grew faster than that at Kingolwira.

The treatment effects are only just becoming apparent in regard to rate of leaf production, but there is a definite disparity in the length of leaf. The plants at Rudewa are tending to produce longer leaf. This is thought to be dependent upon a better rainfall and, in particular, a higher water-table in the soil, both of which would lead to more active and continuous growth. The soil at Rudewa is a greyish-brown alluvial loam while at Kingolwira the soil is a freely-drained red earth derived from gneiss, similar to that at Mlingano.

SISAL EXPERIMENTAL STATION,
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APPENDIX I

Rainfall Records in inches

Month	Mean 1935—45	1946
January	1·16 ...	0·04
February	1·74 ...	0·03
March	5·01 ...	0·14
April	7·79 ...	3·47
May	10·38 ...	11·34
June	2·62 ...	0·60
July	1·47 ...	2·13
August	2·47 ...	2·92
September	2·66 ...	17·27
October	5·14 ...	7·64
November	4·58 ...	1·32
December	2·66 ...	0·78
Total ...	47·68 ...	47·68

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